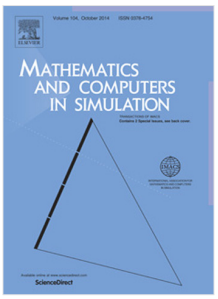
Accepted Manuscript



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PII: S0378-4754(17)30379-8
DOI: https://doi.org/10.1016/j.matcom.2017.12.003
Reference: MATCOM 4523

To appear in: *Mathematics and Computers in Simulation*

Received date : 31 August 2017
Revised date : 1 December 2017
Accepted date : 5 December 2017

Please cite this article as: J. Guo, Y. Kong, Z. Li, W. Huang, J. Cao, Y. Wei, A model and genetic algorithm for area-wide intersection signal optimization under user equilibrium traffic, *Math. Comput. Simulation* (2017), https://doi.org/10.1016/j.matcom.2017.12.003

A model and genetic algorithm for area-wide intersection signal optimization under user equilibrium traffic

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Abstract: The use of signal control systems to reduce traffic movement conflicts at intersections often affects operational efficiency of an urban street network. This study introduces a new method for area-wide traffic signal timing optimization under user equilibrium traffic. The optimization model is formulated as a multi-dimensional search problem aimed to achieve minimized product of the total travel time associated with urban street network and the variance of travel time for unit distance of travel. A genetic algorithm is developed to derive the model solution. A simulation control protocol embedded in PARAMICS software tool capable of conducting area-wide microsimulation is adopted to design the logic frame and function module of the area-wide traffic signal control system. Computational experiment is performed for model application on the Central Business District of Nanjing, China for validation. The results show that mobility improvements are achieved after applying the proposed model along with the genetic algorithm for area-wide signal timing optimization, assessed by extended capacity ratio, and reductions in through and turning movement delays, as well as average and variance of travel time for unit distance of travel.

Keywords： Signal control; User equilibrium; Traffic simulation; Optimization

1 Introduction

The economic prosperity and continuing urbanization have led to rapid increase in travel demand in urban areas. Meanwhile, the capacity expansion of urban street network has not been kept abreast of the demand growth. The demand and supply mismatching has triggered deterioration in urban traffic mobility. Owing largely to land scarcity and prohibited cost of expanding urban streets, solutions have been thought to improve the operational efficiency of the existing street network. One of the effective means is to optimize traffic signal timing plans to reduce vehicle delays at intersections and, in turn, to improve traffic mobility. However, the current signal control systems are often focused on isolated intersections or parallel corridors, which may not improve the mobility of the overall street network. Hence, some road users will experience lower levels of mobility (Stathopoulos and Karlaftis, 2002; Long et al., 2008). According to Wardrop's user equilibrium (UE) principle, the network will be in balance when the road users are aware of exact conditions of the network traffic and are able to actively select the paths with shortest travel times along the respective origin-destination (O-D) paths. When the influence of congestion on travel times of the